

CLAIMS

What is claimed is:

- 5 1. An electrode placement method, comprising:
 locating a plurality of surface electrodes on a thorax of a patient at initial
 locations;
 determining a surface pacing level relative to a pacing limit using at least two
 of the surface electrodes; and
10 selecting or rejecting one or more surface electrode locations based on the
 surface pacing level being within the pacing limit, the selected one or more surface
 electrode locations corresponding to one or more acceptable subcutaneous
 electrode locations.
- 15 2. The method of claim 1, further comprising;
 relocating at least one of the plurality of surface electrodes on the thorax of
 the patient to a new location;
 after relocating, determining a new surface pacing level at the new location;
 and
20 selecting or rejecting the one or more surface electrode locations using the
 new surface pacing level.
3. The method of claim 1, further comprising relocating at least one of the
 plurality of surface electrodes on the thorax of the patient until a new surface pacing
25 level falls within the pacing limit.

4. The method of claim 1, wherein selecting or rejecting the one or more surface electrode locations comprises selecting a location suitable for implantation of a subcutaneous cardiac stimulation electrode.

5 5. The method of claim 4, further comprising implanting the subcutaneous cardiac stimulation electrode at the selected location.

6. The method of claim 1, wherein selecting or rejecting the one or more surface electrode locations comprises selecting locations suitable for implantation of a plurality of subcutaneous cardiac stimulation electrodes.

7. The method of claim 6, further comprising implanting the plurality of subcutaneous cardiac stimulation electrodes at the selected locations.

15 8. The method of claim 1, wherein locating the plurality of surface electrodes comprises locating an array of electrode elements.

9. The method of claim 1, wherein locating the plurality of surface electrodes comprises locating an array of surface electrode elements, and wherein selecting or rejecting the one or more electrode locations comprises scanning the array of surface electrode elements for their associated pacing levels.

10. The method of claim 9, wherein selecting or rejecting the one or more electrode locations further comprises selecting one or more electrode element locations having the lowest pacing levels.

11. The method of claim 1, wherein selecting or rejecting the one or more surface electrode locations comprises selecting locations suitable for implantation of

a subcutaneous cardiac stimulation electrode and a cardiac stimulation system housing.

12. The method of claim 11, further comprising implanting the
5 subcutaneous cardiac stimulation electrode and the cardiac stimulation system housing at their respective subcutaneous locations.

13. The method of claim 1, further comprising contra-indicating the patient
10 for implantation of a subcutaneous cardiac stimulation system based on the surface pacing level exceeding the pacing limit.

14. The method of claim 2, further comprising rejecting the patient for
implantation of a subcutaneous cardiac stimulation system based on the new surface
15 pacing level exceeding the pacing limit.

15. The method of claim 1, wherein selecting or rejecting the one or more
surface electrode locations comprises:

locating a first surface electrode in relation to a superior aspect of the patient's
heart; and

20 locating a second surface electrode in relation to an inferior aspect of the
patient's heart.

16. The method of claim 1, wherein selecting or rejecting the one or more
surface electrode locations comprises locating at least one surface electrode
25 substantially parallel to a ventricular free wall of the patient's heart.

17. The method of claim 1, wherein selecting or rejecting the one or more
surface electrode locations comprises locating at least one surface electrode parallel

to a ventricular free wall of the patient's heart and extending a predetermined distance beyond the apex of the patient's heart.

5 18. An electrode placement method, comprising:
 selecting one or more surface electrode locations as a function of a
surface cardiac pacing level; and
 determining one or more subcutaneous electrode implant locations using
the selected one or more surface electrode locations.

10 19. The method of claim 18, further comprising implanting one or more
subcutaneous cardiac stimulation electrodes at the determined one or more
subcutaneous electrode implant locations.

15 20. The method of claim 18, wherein determining the one or more
subcutaneous electrode implantation locations comprises selecting locations for
implantation of a plurality of subcutaneous cardiac stimulation electrodes.

20 21. The method of claim 20, further comprising implanting the plurality of
subcutaneous cardiac stimulation electrodes at the selected implantation locations.

 22. The method of claim 18, wherein determining the one or more
subcutaneous electrode implantation locations comprises selecting locations for
implantation of a subcutaneous cardiac stimulation electrode and a cardiac
stimulation system housing.

25 23. The method of claim 22, further comprising implanting the
subcutaneous cardiac stimulation electrode and cardiac stimulation system housing
at the selected implant locations.

24. The method of claim 18, wherein selecting the one or more surface electrode locations comprises:

5 locating a first surface electrode in relation to a superior aspect of the heart;
 and
 locating a second surface electrode in relation to an inferior aspect of the heart.

25. The method of claim 18, wherein selecting the one or more surface
10 electrode locations comprises locating at least one surface electrode substantially parallel to a ventricular free wall.

26. The method of claim 18, wherein selecting the one or more surface
15 electrode locations comprises locating at least one surface electrode parallel to a ventricular free wall and extending a predetermined distance beyond the apex of the heart.

27. A medical system, comprising:
 a pulse generator configured to deliver a pacing stimulus at a stimulus
20 level;
 detection circuitry;
 a plurality of surface electrodes coupled to the pulse generator and to the detection circuitry, the plurality of surface electrodes configured for positioning on a thorax of a patient relative to a patient's heart; and
25 a controller coupled to the pulse generator and detection circuitry, the controller determining acceptable subcutaneous electrode locations based at least in part on detection of capture or non-capture resulting from delivery of the pacing stimulus at the stimulus level.

28. The system of claim 27, wherein the controller determines acceptable subcutaneous electrode locations based at least in part on a pre-established proportionality relationship between the stimulus level of the pacing stimulus and a subcutaneous defibrillation level.

29. The system of claim 28, wherein the subcutaneous defibrillation level comprises a level of subcutaneous defibrillation energy above which a particular subcutaneous defibrillation device is not suited to deliver.

30. The system of claim 28, wherein the subcutaneous defibrillation level comprises a level of subcutaneous defibrillation energy below which a particular subcutaneous defibrillation device is suited to deliver.

31. The system of claim 27, comprising a recording arrangement coupled to the controller and configured to record capture threshold data or non-capture data determined for selected thoracic locations of the plurality of surface electrodes.

32. The system of claim 27, comprising a user interface coupled to the controller and configured to present capture threshold data or non-capture data determined for selected thoracic locations of the plurality of surface electrodes.

33. The system of claim 27, further comprising a cardioversion/defibrillation device configured for performing induction testing.

34. The system of claim 27, wherein the pulse generator is configured to deliver cardioversion/defibrillation stimulation to the patient's heart.

35. The system of claim 27, further comprising a housing, the plurality of surface electrodes supported by or coupled to the housing.

5 36. The system of claim 35, wherein the housing comprises a handle and is configured for hand-held portability.

10 37. The system of claim 27, further comprising a housing, the pulse generator and detection circuitry provided in the housing, and the plurality of surface electrodes coupled to the housing.

38. The system of claim 27, further comprising a housing, the pulse generator, detection circuitry, and controller provided in the housing, respectively, and the plurality of surface electrodes coupled to the housing.

15 39. The system of claim 31, further comprising a housing, the pulse generator, detection circuitry, controller, and recording arrangement supported by the housing, respectively, and the plurality of surface electrodes coupled to the housing.

20 40. The system of claim 32, further comprising a housing, the pulse generator, detection circuitry, controller, and user interface supported by the housing, respectively, and the plurality of surface electrodes coupled to the housing.

25 41. The system of claim 27, further comprising an electrode array structure configured to support the plurality of surface electrodes in an array arrangement, the electrode array structure configured to be positionable on the patient's thorax.

42. The system of claim 41, wherein the controller is configured to coordinate scanning of selected combinations of the plurality of surface electrodes.

43. The system of claim 41, wherein the controller is configured to coordinate scanning of combinations of the plurality of surface electrodes and identify surface electrode combinations associated with the lowest pacing levels that effect cardiac capture.

44. A medical system, comprising:
a plurality of surface electrodes configured for positioning on a thorax of a patient relative to a patient's heart;
10 means for determining a surface pacing level relative to a pacing limit using at least two of the surface electrodes; and
means for selecting or rejecting one or more surface electrode locations based on the surface pacing level being within the pacing limit, the selected one or more surface electrode locations corresponding to one or more acceptable
15 subcutaneous electrode locations.

45. The system of claim 44, further comprising means for selecting one or more electrodes of the plurality of surface electrodes associated with the lowest pacing levels that effect cardiac capture.

46. The system of claim 44, further comprising means for scanning combinations of the plurality of surface electrodes and means for identifying surface electrode combinations associated with the lowest pacing levels that effect cardiac capture.

47. The system of claim 44, wherein the means for selecting or rejecting comprises means for determining the one or more acceptable subcutaneous electrode locations based at least in part on a pre-established proportionality relationship between a surface pacing level and a subcutaneous defibrillation level.

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48. A medical system, comprising:
means for selecting one or more surface electrode locations as a function of a surface cardiac pacing level; and
means for determining one or more subcutaneous electrode implant locations using the selected one or more surface electrode locations.

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49. The system of claim 48, further comprising means for determining suitability of the one or more subcutaneous electrode implant locations based at least in part on a pre-established proportionality relationship between the surface cardiac pacing level and a subcutaneous defibrillation level.

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50. A medical system, comprising:
a pulse generator configured to deliver a pacing stimulus at a stimulus level;
an electrode support assembly;
a plurality of surface electrodes coupled to the pulse generator and supported by the electrode support assembly, the plurality of electrodes having a fixed spatial relationship relative to one another and configured for positioning on a thorax of a patient relative to the patient's heart;
detection circuitry; and
a controller coupled to the pulse generator and detection circuitry, the controller determining acceptable subcutaneous electrode locations based at least in

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part on detection of capture or non-capture resulting from delivery of the pacing stimulus at the stimulus level.

51. The system of claim 50, wherein the controller determines acceptable
5 subcutaneous electrode locations based at least in part on a pre-established proportionality relationship between the pacing level of the pacing stimulus and a subcutaneous defibrillation level.

52. The system of claim 50, wherein the controller determines acceptable
10 subcutaneous electrode locations based at least in part on inducing an arrhythmia in the patient and determining the defibrillation level that terminates the arrhythmia.

53. An electrode placement method, comprising:
providing at least a pair of surface electrodes situated on a support
15 structure, the pair of surface electrodes comprising a first and second surface electrodes having a fixed spatial relationship relative to one another;
locating the first surface electrode at a first location on a thorax of a patient;
moving the support structure to locate the second surface electrode at
20 a second location on the patient's thorax;
determining a surface pacing threshold for effecting cardiac capture using the first and second surface electrodes;
selecting one or more surface electrode locations as a function of the surface pacing threshold; and
25 determining one or more subcutaneous electrode implant locations using the selected one or more surface electrode locations.

54. The method of claim 53, wherein:
the first surface electrode is located relative to an apex of the patient's heart; and

5 moving the support structure comprises rotating the support structure relative to the first surface electrode location to position the second surface electrode at the second location on the patient's thorax.

55. The method of claim 53, wherein the first surface electrode is located
10 relative to an apex of the patient's heart and the second surface electrode is located in relation to a superior aspect of the patient's heart.

56. The method of claim 53, further comprising rotating the second surface electrode relative to the first surface electrode location while maintaining the fixed
15 spatial relationship.

57. The method of claim 53, wherein the first surface electrode is located in relation to an inferior aspect of the patient's heart and the second surface electrode is located in relation to a superior aspect of the patient's heart.
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58. The method of claim 53, further comprising relocating the first surface electrode and the second surface electrode to respective new locations on the thorax of the patient.

25 59. The method of claim 53, further comprising inducing an arrhythmia in the patient using the first and second surface electrodes.

60. The method of claim 59, further comprising delivering defibrillation energy to the patient at first and second surface electrode locations in response to the induced arrhythmia.